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(54) **METHOD FOR FALSE COLOR SUPPRESSION**

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(58) **Field of Classification Search** 348/607, 348/609, 666, 621, 624, 702, 448, 452, 450; 382/167, 275; 345/611
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,530,004	A	7/1985	Achiha et al.
4,670,773	A	6/1987	Silverberg
4,706,112	A	11/1987	Faroudja et al.
4,723,157	A	2/1988	Wendland et al.
4,731,660	A	3/1988	Faroudja et al.
4,831,463	A	5/1989	Faroudja
4,837,611	A	6/1989	Faroudja
4,893,176	A	1/1990	Faroudja
4,916,526	A	4/1990	Faroudja et al.
4,918,515	A	4/1990	Faroudja
4,943,849	A	7/1990	Faroudja et al.
4,967,271	A	10/1990	Campbell et al.
4,982,280	A	1/1991	Lyon et al.
4,984,068	A	1/1991	Sugiyama et al.
5,012,329	A	4/1991	Lang et al.
5,019,895	A	5/1991	Yamamoto et al.
5,023,713	A	6/1991	Nishigori
5,027,194	A	6/1991	Scheffler

(Continued)

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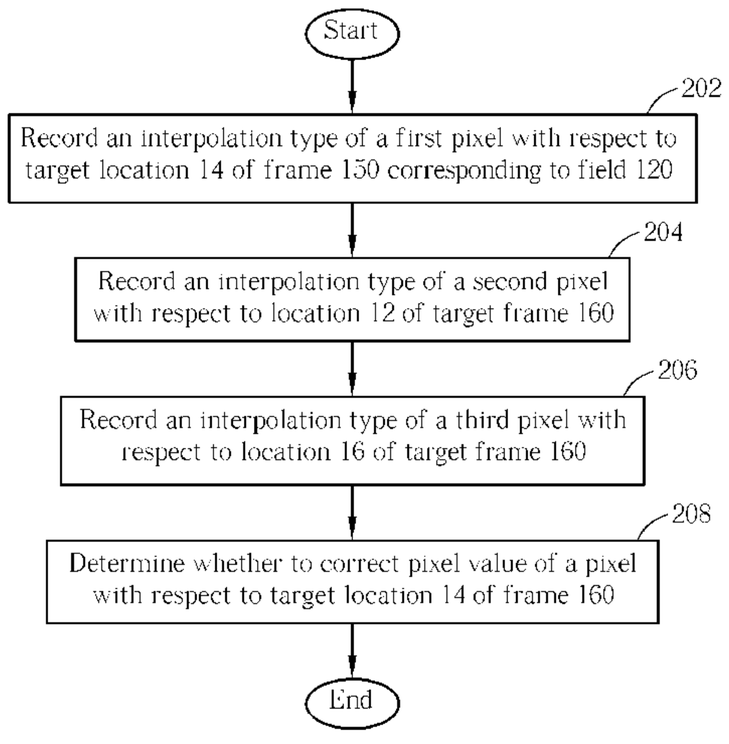
(57) **ABSTRACT**

A false-color suppression method corrects a pixel value of a pixel in a target location of a target frame while de-interlacing video data. The video data includes consecutive first, second and third fields, and the target frame corresponds to the third field. The method records an interpolation type of a first pixel with respect to the target location of a previous frame corresponding to the second field, and corrects the pixel value of the pixel in the target location of the target frame using a pixel value of a reference pixel if the interpolation type of the first pixel is an inter-field interpolation.

20 Claims, 2 Drawing Sheets



U.S. PATENT DOCUMENTS

5,051,826	A	9/1991	Ishii	
5,055,920	A	10/1991	Illetschko et al.	
5,063,438	A	11/1991	Faroudja	
5,146,318	A	9/1992	Ishizuki et al.	
5,249,037	A	9/1993	Sugiyama et al.	
5,305,095	A	4/1994	Song	
5,305,120	A	4/1994	Faroudja	
5,428,398	A	6/1995	Faroudja	
5,448,305	A	9/1995	Hagino	
5,457,501	A	10/1995	Hong	
5,475,438	A	12/1995	Bretl	
5,483,294	A	1/1996	Kays	
5,502,509	A	3/1996	Kurashita et al.	
5,689,301	A	11/1997	Christopher	
6,034,733	A *	3/2000	Balram et al.	348/448
6,052,312	A *	4/2000	Ishii	365/189.04
6,108,041	A	8/2000	Faroudja	
6,133,957	A	10/2000	Campbell	
6,317,165	B1 *	11/2001	Balram et al.	348/699
6,580,463	B2	6/2003	Swartz	
6,891,571	B2	5/2005	Shin	
6,956,620	B2	10/2005	Na	
6,987,884	B2	1/2006	Kondo et al.	
6,995,804	B2	2/2006	Kwon et al.	
7,061,548	B2	6/2006	Piepers	
7,084,923	B2 *	8/2006	Brown Elliott et al.	348/441
7,098,957	B2	8/2006	Kim et al.	
7,271,850	B2 *	9/2007	Chao	348/609
7,280,159	B2 *	10/2007	Chao	348/609
2003/0112369	A1	6/2003	Yoo	
2004/0017507	A1 *	1/2004	Clayton	348/407.1
2004/0114048	A1	6/2004	Jung	
2005/0018086	A1	1/2005	Lee	
2005/0134745	A1	6/2005	Bacche et al.	
2005/0168650	A1	8/2005	Walls et al.	
2005/0270415	A1	12/2005	Jiang	
2006/0187344	A1 *	8/2006	Corral Soto	348/452
2006/0203125	A1 *	9/2006	Sayre	348/459
2006/0228022	A1 *	10/2006	Chao	382/167

* cited by examiner

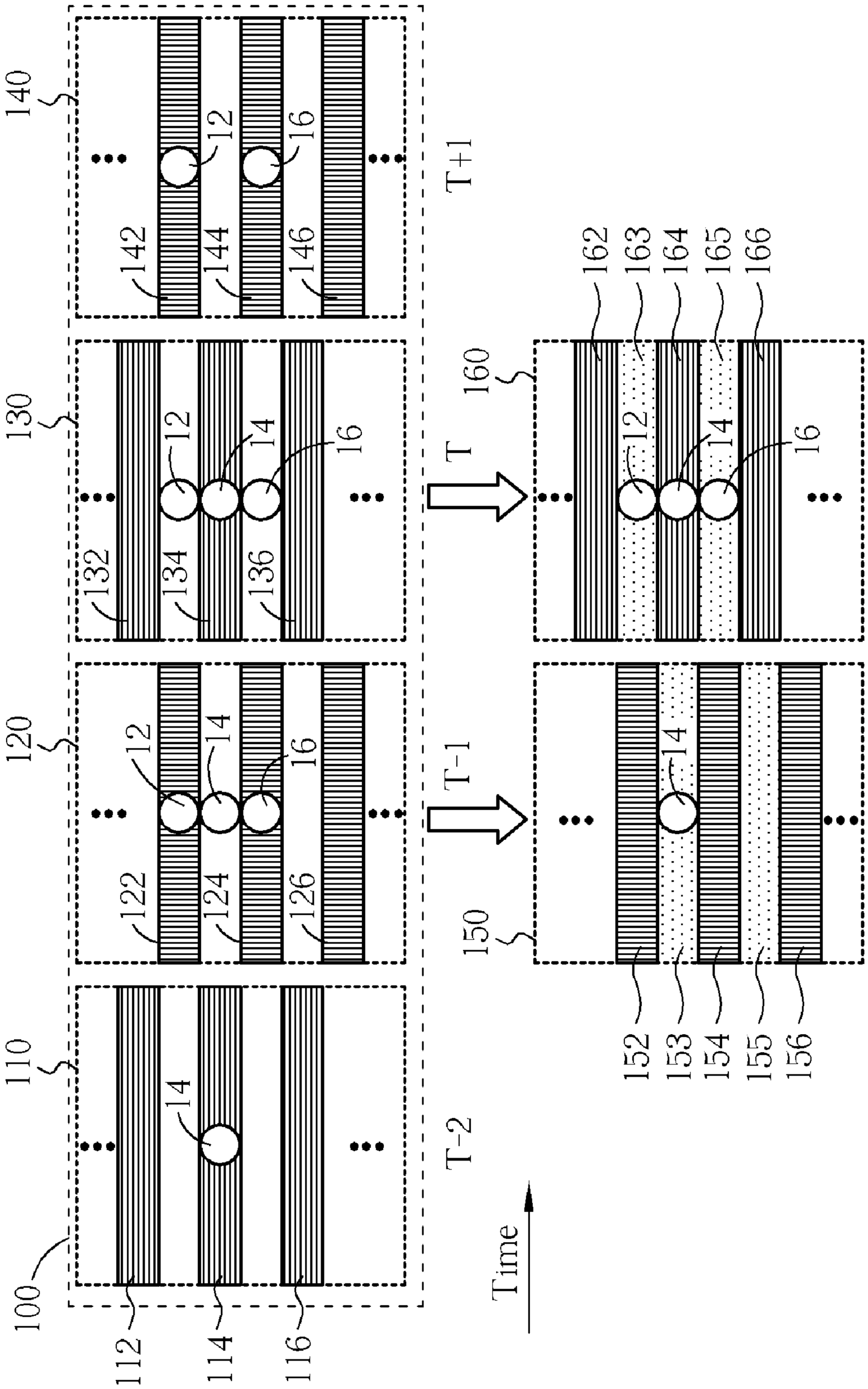

140
142
144
146
12
16
T+1
162
163
164
165
166
160
T
130
132
134
136
12
14
16
120
122
124
126
12
14
16
T-1
150
152
153
154
155
156
110
100
112
114
116
14
T-2
Time

Fig. 1

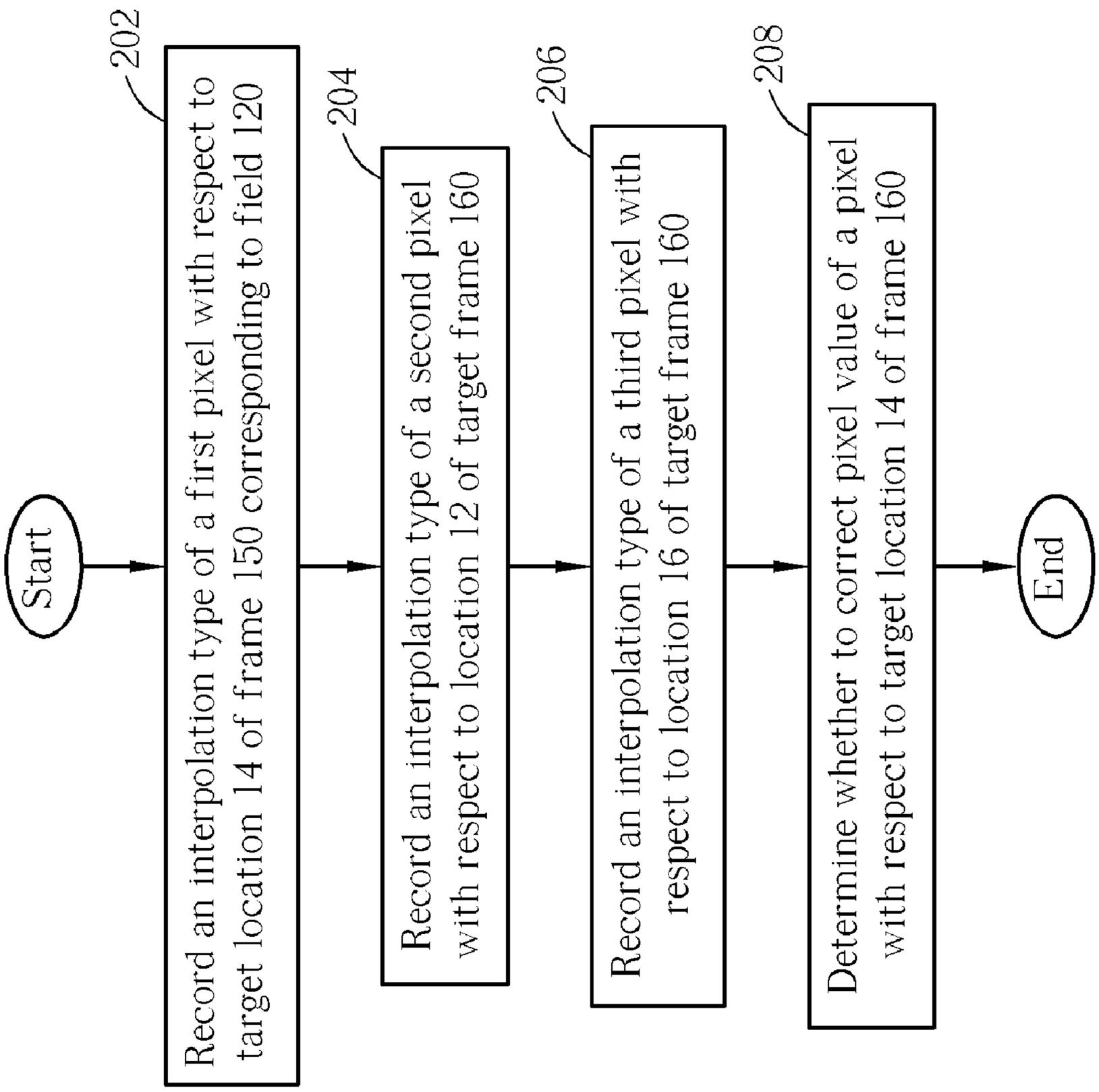

Start
202
Record an interpolation type of a first pixel with respect to target location 14 of frame 150 corresponding to field 120
204
Record an interpolation type of a second pixel with respect to location 12 of target frame 160
206
Record an interpolation type of a third pixel with respect to location 16 of target frame 160
208
Determine whether to correct pixel value of a pixel with respect to target location 14 of frame 160
End

Fig. 2

METHOD FOR FALSE COLOR SUPPRESSION

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. patent application Ser. No. 10/710,072, filed Jun. 16, 2004, entitled "Method and Apparatus for Cross Color and/or Cross Luminance Suppression", U.S. patent application Ser. No. 10/710,340, filed Jul. 2, 2004, entitled "Method and Apparatus for Cross Color/Cross Luminance Suppression", and U.S. patent application Ser. No. 11/161,727, filed Aug. 15, 2005, entitled "De-interlacing Method", which are incorporated in their entirety herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to video processing, and more particularly, to false-color suppression.

2. Description of the Prior Art

Conventional television signals (including NTSC format TV signals and PAL format TV signals) are composed of luminance signals and chrominance signals. Generally, the luminance signals and chrominance signals are superimposed on the same carrier within the television signals. When a television receives the television signals, it needs to separate the luminance signals and the chrominance signals so as to display images on the screen.

If the luminance signals and chrominance signals are not completely separated, the problems of cross-color or cross-luminance can arise (collectively, false color effect). As a result, some image defects such as false color artifacts may be present on the screen.

Conventional false-color suppression operations need to perform video detections to determine if the image is still (or stationary) so as to decide the most suitable false-color suppression operation. However, the conventional art not only needs a considerable computational requirement but also needs additional memory space to store video data required for the video detections.

SUMMARY OF THE INVENTION

It is therefore an objective of the invention to provide a method of false-color suppression with reduced computational requirement as well as memory space.

According to a preferred embodiment of the present invention, a false-color suppression method is disclosed. The method is used for correcting a pixel value of a pixel in a target location of a target frame while de-interlacing video data including consecutive first, second and third fields, wherein the target frame corresponds to the third field. The method comprises: recording an interpolation type of a first pixel with respect to the target location of a previous frame corresponding to the second field; and correcting the pixel value of the pixel in the target location of the target frame using a pixel value of a reference pixel if the interpolation type of the first pixel is an inter-field interpolation.

According to an embodiment of the present invention, another false-color suppression method for correcting a pixel value of a pixel in a target location of a target frame generated from video data is disclosed. The video data includes consecutive first, second and third fields, and the target frame corresponds to the third field. The method comprises: generating a first pixel value for the target location of an output

frame corresponding to the second field; and correcting the pixel value of the pixel in the target location of the target frame using a pixel value of a reference pixel if the first pixel is generated through an inter-field interpolation.

According to an embodiment of the present invention, a video processing method is disclosed comprising: when de-interlacing video data, selecting one of a plurality of interpolation types for each pixel location to be processed so as to calculate a corresponding pixel value for each pixel location; recording the selected interpolation type of each pixel location to be processed; and determining whether to perform a false-color suppression operation for a calculated pixel value according to the corresponding recorded interpolation type.

According to an embodiment of the present invention, a video processing method for processing video data having a plurality of input image fields to generate a plurality of output image frames is disclosed comprising: for each pixel location of at least a portion of a frame among the output image frames, determining a type of interpolation operation; for each said pixel location, performing a de-interlacing operation by performing interpolation on a plurality of pixel values of the input image fields according to the determined type of interpolation operation, to generate a pixel value of each said pixel location; and for a first pixel location of said portion, determining whether to perform a false-color suppression operation according to the determined types of interpolation operation of a plurality of pixel locations of said portion, to correct the pixel value of said pixel location.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing video data including four consecutive fields and two corresponding output frames according to an embodiment of the present invention.

FIG. **2** is a flowchart illustrating an operation of correcting a pixel value of a target location of a frame according to an embodiment of the present invention.

DETAILED DESCRIPTION

Please refer to FIG. **1**, which depicts a diagram showing four consecutive fields of a video data **100** and two corresponding de-interlaced output frames **150** and **160** according to an embodiment of the present invention. The output frames **150** and **160** correspond to times T−1 and T, respectively. The four consecutive fields **110**, **120**, **130**, and **140** correspond to times T−2, T−1, T, and T+1, respectively. In FIG. **1**, scan lines **112**, **122**, **132**, and **142** are respectively the (N−1)th scan lines of fields **110**, **120**, **130**, and **140**; scan lines **114**, **124**, **134**, and **144** are respectively the Nth scan lines of fields **110**, **120**, **130**, and **140**; and scan lines **116**, **126**, **136**, and **146** are respectively the (N+1)th scan lines of fields **110**, **120**, **130**, and **140**.

Note that the term "pixel value" mentioned hereinafter indicates the luminance or chrominance of a pixel.

The output frames **150** and **160** are de-interlaced from the video data **100** on a pixel-by-pixel basis. When de-interlacing the video data **100**, the pixel values of the scan lines **153** and **155** of the output frame **150** can be generated by interpolation using pixel values of fields **110** and **130**, which are the preceding field and succeeding field of the field **120** corresponding to time T−1. The pixel values of the scan lines **152**, **154**, and **156** of the output frame **150** are typically generated by

adopting pixel values of the scan lines **122**, **124** and, **126** of the field **120**. Similarly, the scan lines **162**, **164**, and **166** of the output frame **160** are typically generated by adopting the scan lines **132**, **134**, and **136** of the field **130** corresponding to time T. The de-interlacing process is well known in the art and the details are thus omitted herein.

However, pixels of the scan lines in the fields **120** and **130** may present false color as mentioned earlier. In order to reduce the defect caused by pixels with false color, a false-color suppression method correcting pixel values of the scan lines of the output frame according to the detection results obtained in a motion adaptive de-interlacing process of the video data **100** is hereinafter introduced. One of ordinary skill in the art will understand that the false-color suppression method to be detailed can be implemented along with various known or new motion adaptive de-interlacing or motion compensation de-interlacing processes.

For example, when de-interlacing the video data **100** to generate a pixel value for a location **16** of the output frame **160**, the de-interlacing operation detects if the image surrounding the location **16** is still, or stationary. If the surrounding image of the location **16** is deemed still, the de-interlacing operation performs an inter-field interpolation to generate the pixel value of the location **16** of the output frame **160** based on pixel values of pixels of the fields **120** and **140** corresponding to the location **16**. On the contrary, if the neighboring image of the location **16** is deemed not still, the de-interlacing operation performs an intra-field interpolation to generate the pixel value of the location **16** of the output frame **160** based on pixel values of pixels of the field **130**. In other words, the de-interlacing operation performs either the inter-field interpolation or the intra-field interpolation to generate the pixel value of the location **16** of the output frame **160** according to a detecting result of a stillness or stationary detection of the image surrounding or in the vicinity of the target location **16**.

If the de-interlacing operation decides to perform the inter-field interpolation to generate the pixel value of the location **16** of the output frame **160**, this means that the pixel value of the location **16** of the field **120** is to certain degree similar to the pixel value of the location **16** of the field **140**. Based on this characteristic, the detection result of the de-interlacing operation (i.e., whether to use inter-field interpolation or intra-field interpolation) can alone determine whether or not the image of a specific location is still in a false-color suppression context, without adopting other pixel detections. The correction of a pixel value of a target location **14** of the output frame **160** based on the detection results obtained in the de-interlacing operation is described with a flowchart as an embodiment of the present invention.

FIG. **2** shows a flowchart **200** illustrating an operation of correcting a pixel value of the target location **14** of the output frame **160** according to an embodiment of the present invention. The steps of the flowchart **200** are described as follows:

In step **202**, the false-color suppression method of this embodiment records the interpolation type of a first pixel value of the target location **14** of the output frame **150** while de-interlacing the video data **100** to generate the output frame **160**. For example, if the first pixel value of the target location **14** of the output frame **150** is generated through the inter-field interpolation, a bit "1" is accordingly recorded in step **202** as a mark. On the other hand, if the first pixel value is not generated through the inter-field interpolation, a bit "0" is accordingly recorded in step **202** as a mark. In practical implementations, the above marks can be recorded in a buffer.

The de-interlacing process mentioned above that determines the interpolation type, for example, in this embodiment, either inter-field interpolation or intra-field interpolation, can be implemented by performing a motion adaptive de-interlacing process or a motion compensation de-interlacing process, such as that being described in U.S. patent application Ser. No. 11/161,727, filed Aug. 15, 2005, entitled "De-interlacing method", which shares the same inventor as the present invention and is incorporated in its entirety herein by reference, or other known or new de-interlacing processes.

Similarly, while generating the output frame **160**, the false-color suppression method of this embodiment performs step **204** to record the interpolation type of a second pixel value of a location **12** of the output frame **160** into the buffer. In this embodiment, if the second pixel value is generated through the inter-field interpolation, step **204** also records a bit "1" as a mark; otherwise, it records a bit "0".

In step **206**, the false-color suppression method of this embodiment records the interpolation type of a third pixel value of the location **16** of the output frame **160** into the buffer in the same way.

In step **208**, the false-color suppression method of this embodiment can determine whether to perform a false-color correction on the pixel value of the target location **14** of the output frame **160** according to the bits recorded in the above steps. For example, if the first pixel value of the target location **14** of the output frame **160**, the second pixel value of the location **12** of the output frame, and the third pixel value of the location **16** of the output frame **160** are all generated through the inter-field interpolation, the surrounding image of the target location **14** can be reasonably determined as still. In this situation, if the video data **100** is in NTSC format, the false-color suppression method of this embodiment performs a false-color correction on the pixel value of the target location **14** of the output frame **160** with a pixel value of the field **110** corresponding to the target location **14**. The false-color correction comprises a cross-color suppression operation and a cross-luminance suppression operation. Both the cross-color suppression and cross-luminance suppression operations are well known in the art, such as those being described in U.S. patent application Ser. No. 10/710,072, filed Jun. 16, 2004, entitled "Method and Apparatus for Cross Color and/or Cross Luminance Suppression", or in U.S. patent application Ser. No. 10/710,340, filed Jul. 2, 2004, entitled "Method and Apparatus for Cross Color/Cross Luminance Suppression", both of which share the same inventor as the present invention, and are incorporated in their entirety herein by reference, and further details are thus omitted for brevity.

Note that the locations **12** and **16** are not limited to be in the vertical direction of the target location **14**. In addition, the location **12** is not limited to be in the previous scan line of the target location **14**. Similarly, the location **16** is not limited to be in the following scan line of the target location **14**. Moreover, step **208** can be performed based the interpolation types of more pixel locations.

As mentioned above, if the first pixel value of the target location **14** of the output frame **150** is generated through the inter-interpolation, this means that the pixel value of the field **110** and the pixel value of the field **130** with respect to the target location **14** are similar. Therefore, the interpolation type of the first pixel value of the target location **14** of the output frame can be employed to determine whether to correct the pixel value of the target location **14** of the output frame **160**.

Additionally, although the above embodiment is described in an NTSC application, a person skilled in the art should realize that the false-color suppression method of the present invention can also be applied in other TV systems, such as the PAL system. For example, if the video data **100** is in the PAL format and the false-color suppression method mentioned

above determines that the pixel value of the target location **14** of the output frame **160** needs to be corrected, a pixel value of the target location **14** of a field corresponding to time T−4 can be used to correct the pixel value of the target location **14** of the output frame **160**.

As mentioned, the false-color suppression method of the above embodiment only requires the detection results obtained in the de-interlacing operation to determine if the surrounding image of the target location **14** is still. The method does not require other detections. The computational requirement is thereby significantly reduced. In addition, the method only temporarily stores the interpolation type of a pixel, so that only a small memory space (or buffer space) is required, and the hardware complexity and cost is thereby reduced.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A false-color suppression method for correcting a pixel value of a pixel in a target location of a target frame while de-interlacing video data including consecutive first, second, and third fields, wherein the target frame corresponds to the third field, the method comprising:

(a) recording an interpolation type of a first pixel with respect to the target location of a previous frame corresponding to the second field; and

(b) correcting the pixel value of the pixel in the target location of the target frame using a pixel value of a reference pixel if the interpolation type of the first pixel is an inter-field interpolation.

2. The method of claim **1**, wherein the reference pixel is located in the target location within the first field.

3. The method of claim **1**, wherein the third field corresponds to time T while the first field corresponds to time T−2, and the reference pixel is located in the target location within a field corresponding to time T−4.

4. The method of claim **1**, further comprising:

recording an interpolation type of a second pixel with respect to a second location of the target frame;

wherein a scan line to which the second location belongs is prior to a scan line to which the target location belongs, and step (b) corrects the pixel value of the pixel in the target location of the target frame using the pixel value of the reference pixel only if the interpolation type of the second pixel is an inter-field interpolation.

5. The method of claim **4**, further comprising:

recording an interpolation type of a third pixel with respect to a third location of the target frame;

wherein a scan line to which the third location belongs is subsequent to a scan line to which the target location belongs, and step (b) corrects the pixel value of the pixel in the target location of the target frame using the pixel value of the reference pixel only if the interpolation type of the third pixel is an inter-field interpolation.

6. A false-color suppression method for correcting a pixel value of a pixel in a target location of a target frame generated from video data, the video data including consecutive first, second and third fields, wherein the target frame corresponds to the third field, the method comprising:

(a) generating a first pixel value for the target location of an output frame corresponding to the second field; and

(b) correcting the pixel value of the pixel in the target location of the target frame using a pixel value of a reference pixel if the first pixel is generated through an inter-field interpolation.

7. The method of claim **6**, wherein the reference pixel is located in the target location within the first field.

8. The method of claim **6**, wherein the third field corresponds to time T while the first field corresponds to time T−2, and the reference pixel is located in the target location within a field corresponding to time T−4.

9. The method of claim **6**, further comprising:

generating a second pixel value for a second location of the target frame;

wherein a scan line to which the second location belongs is prior to a scan line to which the target location belongs, and step (b) corrects the pixel value of the pixel in the target location of the target frame using the pixel value of the reference pixel only if the second pixel is generated through an inter-field interpolation.

10. The method of claim **9**, further comprising:

generating a third pixel value for a third location of the target frame;

wherein a scan line to which the third location belongs is subsequent to a scan line to which the target location belongs, and step (b) corrects the pixel value of the pixel in the target location of the target frame using the pixel value of the reference pixel only if the third pixel is generated through an inter-field interpolation.

11. The method of claim **6**, wherein the target frame is generated through a motion adaptive de-interlacing operation.

12. A video processing method comprising:

when de-interlacing video data, selecting one of a plurality of interpolation types for each pixel location to be processed so as to calculate a corresponding pixel value for each pixel location;

recording the selected interpolation type of each pixel location to be processed; and

determining whether to perform a false-color suppression operation for a calculated pixel value according to the corresponding recorded interpolation type.

13. The method of claim **12**, wherein the plurality of interpolation types comprises an inter-filed interpolation and an intra-field interpolation.

14. The method of claim **12**, wherein the false-color suppression operation comprises a cross-color suppression operation.

15. The method of claim **12**, wherein the false-color suppression operation comprises a cross-luminance suppression operation.

16. A video processing method for processing video data having a plurality of input image fields to generate a plurality of output image frames, the method comprising:

for each pixel location of at least a portion of a frame among the output image frames, determining a type of interpolation operation;

for each said pixel location, performing a de-interlacing operation by performing interpolation on a plurality of pixel values of the input image fields according to the determined type of interpolation operation, to generate a pixel value of each said pixel location; and

for a first pixel location of said portion, determining whether to perform a false-color suppression operation according to the determined types of interpolation operation of a plurality of pixel locations of said portion, to correct the pixel value of said pixel location.

17. The method of claim 16, wherein the type of interpolation operation is chosen from a set of interpolation operation types comprising inter-field interpolation and intra-field interpolation.

18. The method of claim 16, wherein the false-color suppression operation comprises a cross-color suppression operation.

19. The method of claim 16, wherein the false-color suppression operation comprises a cross-luminance suppression operation.

20. The method of claim 16, further comprising:

recording the determined type of interpolation operation for each said pixel location.

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